Timing of English Vowels spoken with an Arabic Accent

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1. Introduction

This study is intended to provide empirical evidence concerning the extent to which the temporal properties of vowels in English with an Arabic accent resemble native vs. target-language norms. Phonemically Arabic differs from English in that it possesses only three long vowels /ii,aa,uu/ and their short counterparts while English has many more vowels some of which are quite similar to the six Arabic vowels.

A recent experimental study of the Jordanian dialect of colloquial Arabic by Mitleb (1981) has shown that stop voicing does not significantly affect either stop timing in final position in monosyllables or vowel duration. In English, however, it is well known that vowels are much longer before voiced consonants than before voiceless ones (Peterson and Lehiste, 1960) and that closure duration of English voiced consonants in post-stressed position is shorter than that of their corresponding voiceless counterparts (Lisker, 1957).

Arabic, unlike English, possesses a phonotactic constraint that limits monosyllabic words to CVVC and CVCC syllable types (Swadesh 1937). This implies that short vowels /i,u,a/ contrast phonemically with their long counterparts /ii,uu,aa/ (Al-Ani, 1970) but that final single (short) consonants occur only after the long vowels and geminate (long) consonants only occur in syllables with short vowels (Al-Ani, 1970). Thus vowel length and consonant length are not independent in monosyllabic words but are confounded. In English, however, they may appear either after lax (short) or tense (long) vowels. That is, phonological length of a vowel is independent of the final consonants in closed monosyllables (Peterson and Lehiste, 1960). Moreover, in spite of the fact that both languages possess the phonemes /t/ and /d/, American English has an optional rule that generally changes an underlying /t-d/ contrast into apical flap [ɾ] as in *writer* and *rider* (Chomsky, 1964). In American English, this rule also applies across word boundaries to wordfinal /t/ and /d/ as in sentences like 'put it away' and 'read a book'.

Current proposals such as the Contrastive Analysis Hypothesis claim that this interference from the native to foreign language is primarily at the abstract level of phonological or phonetic segmental features rather than at the lower levels such as phonetic implementation. Thus, within the framework of Contrastive Analysis, difficulties that face second-language learners are attributed to differences in phonemic inventories, allophonic membership in phonemic inventories, distributional differences of phonemes and syllable structure differences between the first and second language (Lado, 1957). Accordingly this theory would predict (1) that Arabs should have difficulty in 'unlearning' their syllable structure constraints to produce novel English syllable types, and (2) that Arabs would not learn the optional rule of flapping characteristic of American English in post stressed position. However, it seems that Contrastive Analysis makes no prediction about the difficulty for Arabs to produce the phonetic implementation rules of English. This is because Contrastive Analysis deals only with transcriptions based on traditional articulatory features as basic data. Phonetic transcriptions however, disregard the physical properties of speech sounds under the assumption that such properties are 'supplied by universal rules' (Chomsky and Halle, 1968:295). Yet, recent phonetic studies have shown, for example, that the effect of voicing on preceding vowel duration is not an absolute universal but rather a language-specific variable, (Port, Al-Ani, and Maeda, 1980). This suggests that non-segmental differences exist between the temporal structures of languages that must be accounted for in the analysis of each language (Port, Al-Ani, and Maeda, 1980).

Methods

2.1. Stimulus Materials

The following 12 real or possible English minimal pairs were chosen for this study (beat, bead, bit, bid, bait, bade, bet, bed, boot, booed, *but, *bud, boat, bode, bought, bawd, bot, bod, butt, budd, bat, bad, bite, bide). A list of sentences was prepared on 3×5 cards in a quasi random order. Subjects were instructed on the cards to read the asterisked words to rhyme with *foot* and *could*, that is, /bʊt/ and /bʊd/. Three tokens of each test word embedded in the carrier sentence 'He says ____ again and again'.

2.2. Subjects

Two groups of seven speakers each served in this experiment: an American group and a Jordanian group. The Americans were all male graduate students of linguistics at Indiana University at the age 24-30 and came from a variety of regions of the country. The Jordanians were all male native speakers of Arabic (Jordanian dialect) aged 25-30. The Jordanians had been in the United States for over two years.

2.3. Recordings and Analysis

A total of 72 sentences were read by each subject from cards at normal

speaking tempo and recorded on a Revox A 700 tape recorder. Wide-band spectrograms were made for each token measuring vowel duration and final apical duration.

3. Results

3.1. Vowel Duration

a. Voicing Effect. The ratios of vowel duration in a voiceless environment to that in a voiced one are .80 for Americans ($F(1,3)=157$, $p<.001$) and .91 for Arabic-accented English ($F(1,3)=16.13$, $p<.001$). Due to the smaller size of the voicing effect on vowel duration exhibited by the Jordanians, the interaction of group and voicing is also significant ($F(1,6)=27.6$, $p<.001$). Moreover, these two groups differ significantly with respect to the overall vowel duration ($F(1,4)=298.34$, $p<.001$) which are much shorter (m=138 msec.) for the Jordanian than for American (m=184 msec.).
b. Tensity or Length Effect. The ratios of lax/tense vowel average overall were .85 for Americans and .76 for native Arabic speakers when speaking English. The effect of tensity is significant for both Americans ($F(1,3)=47.7$, $p<.001$) and Arabs ($F(1,3)=89.9$, $p<.001$) independently. Furthermore, the greater tensity effect by the Arab speakers than Americans is also significant (interaction of tensity and group ($F(1,6)=5.60$, $p<.02$).
c. Vowel Height Effect. The percentage difference between all high vs. all low vowels is the same for the two groups. It is significant for both Americans ($F(1.3 = 35.8$, $p<.001$) and Arabs ($F(1,3)=15.9$, $p<.001$) and amounts overall to 14%. As for group and vowel height interaction, however no significant effect is found ($F(1,6)=1.70$, n.s.);

3.2. Apical Stop Closure Duration

a. Voicing Effect. The ratios of t/d are 1.31 for Americans ($F(1,3)=48.79$, $p<.001$) and 1.13 for Arabs ($F(1,3)=404$, $p<.045$). Thus due to the difference in ratio between these two groups of about .21, the interaction of group and voicing is also found to be significant ($F(1,6)=6.18$, $p<.009$).
b. Flapping of Apical Stops. A flap is defined here as having a closure of 40 msec. or shorter than this.[1] Both American controls and Arabs make a good percentage of the total number of English t/s and d/s as apical flap according to the above criteria. The proportion of flapped t/s and d/s is not noticeably different for the two groups. Americans flap about 1/2 of the t/s and 4/5 of the d/s, while Arabs flap 1/2 of the English t/s and 2/3 of the d/s. Chi-square tests on the proportion of flapped t/s and d/s show that American-English is not significantly different from Arabic-accented English (χ^2 (1) = 0.67, n.s.).
c. Vowel Tensity Effect. There is no significant duration difference between consonant closure following tense vowels and that following lax ones for either the American group ($F(1,3)=.075$, n.s.) or the Arab group ($F(1,3)=-198$, n.s.). However, the overall consonant closure duration difference between these two groups amounts to 4.5 msec. ($F(1,4)=13.87$, $p<.001$). Yet, the interaction of group and tensity falls short of significance on consonant closure duration.

1. Zue and Lafferriere (1979) also considered 40 msec. or shorter as their criterion for flapped apical.

4. Review of Results and Conclusions

To clarify the results of our experiment, the results from the Arabic experiment reported in Mitleb (1981) are juxtaposed to those of the English experiment in Figure 1.

In this display, the durations of vowels before /t/ are on the vertical axis and those before /d/ are on the horizontal axis. A diagonal line is drawn indicating points where the vowel before /d/ equals the vowel before /t/. Thus, the nearer a point is to this line, the smaller is the difference between a vowel before a voiced consonant and before a voiceless one. Examining this figure, we note that Arabic exhibited a weak voicing effect on vowel duration. However, Arabic-accented English showed a modest durational difference between vowels as a function of voicing which is stronger than Arabic and weaker than American English.

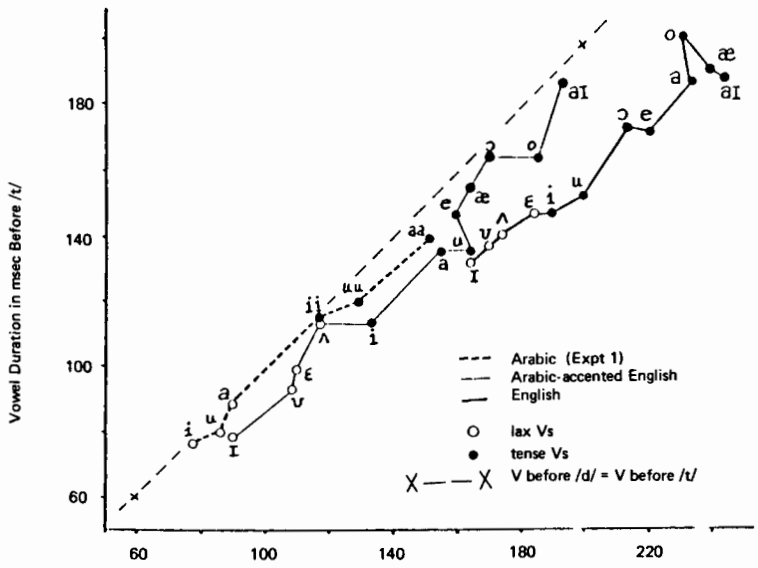

Figure 1. Duration of various vowels before /d/ and /t/ in ms.

Thus, we may conclude that Arabs produce a reduced version of the English voicing effect, and an exaggerated version of the English vowel effect on vowel duration, and exhibit overall vowel durations that are mid-way between Arabic and American English. This conclusion supports, on empirical grounds, the contention of Flege (1981) that foreign-accented speech is an 'approximative system'. However, these results overall run counter to the view that second language learners when faced with new phoneme, allophone, allophonic distribution or syllable type do 'transfer' the structure of the native phonological system in producing the target one (Lado, 1957), since there is no evident interference of 'monosyllabic types' of Arabic on the English production of Arabs. The Jordanians in this experiment flapped /t, d/ in the manner reported for American English. Nevertheless, Arabs seem to use Arabic short and long vowel timing for English lax and tense vowels. Although they lengthen vowels overall, they do not lengthen them enough to match Americans. These results are congruent with earlier studies (Flege and Port, 1981) which proposed that the pronunciation interference from the native language to the target language occurs primarily at the level of phonetic implementation rather than at the level of phonological features and phonotactics.

Overall, then, none of the cases of potential interference from the native language to the target language examined in this study that could be specified in straightforward segmental terms - like phonotactic constraint or allophonic rules - give evidence of posing particular difficulties for our subjects. Yet our data do provide some evidence that phonetic implementation-level differences between languages are a source of interference from the native language into the second language. Thus, our results on foreign accent appear to provide support for the hypothesis that differences at the segmental levels of phonological and phonetic elements between languages are easier to overcome than differences at the temporal implementation level for an adult language learner.

Acknowledgements

I would like to thank Robert Port for the extensive assistance in completing this study. This research was supported by the Yarmouk University, Irbid, Jordan.

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